

EMBEDDED MULTIPROCESSOR TECHNOLOGY FOR VHSIC INSERTION

**Presented at
Technology for Space Station Evolution
- A Workshop**

January 16-19, 1990

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**ST 27213-10-29
N 93-3601**

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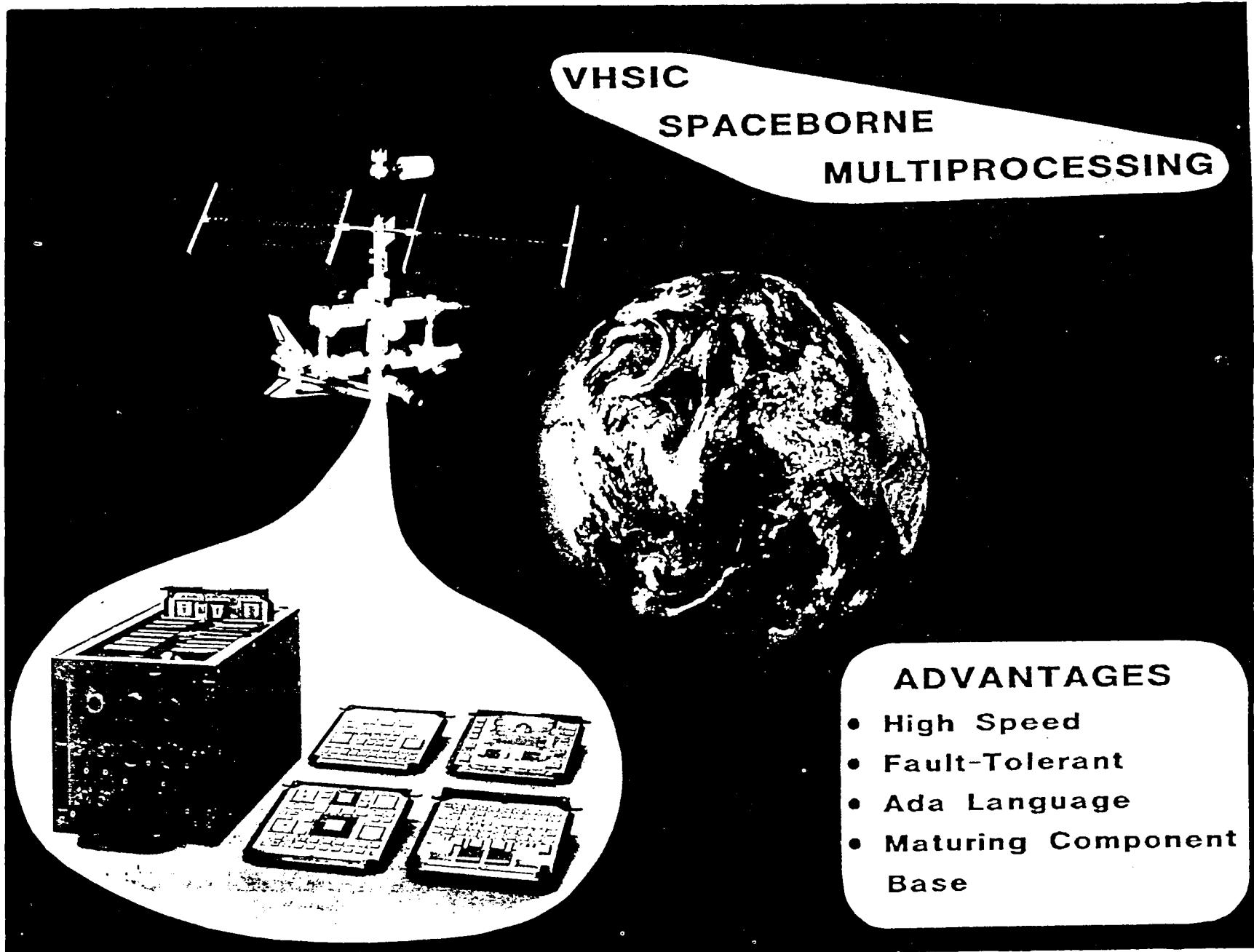
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NASA MULTIPROCESSOR TECHNOLOGY

OBJECTIVE

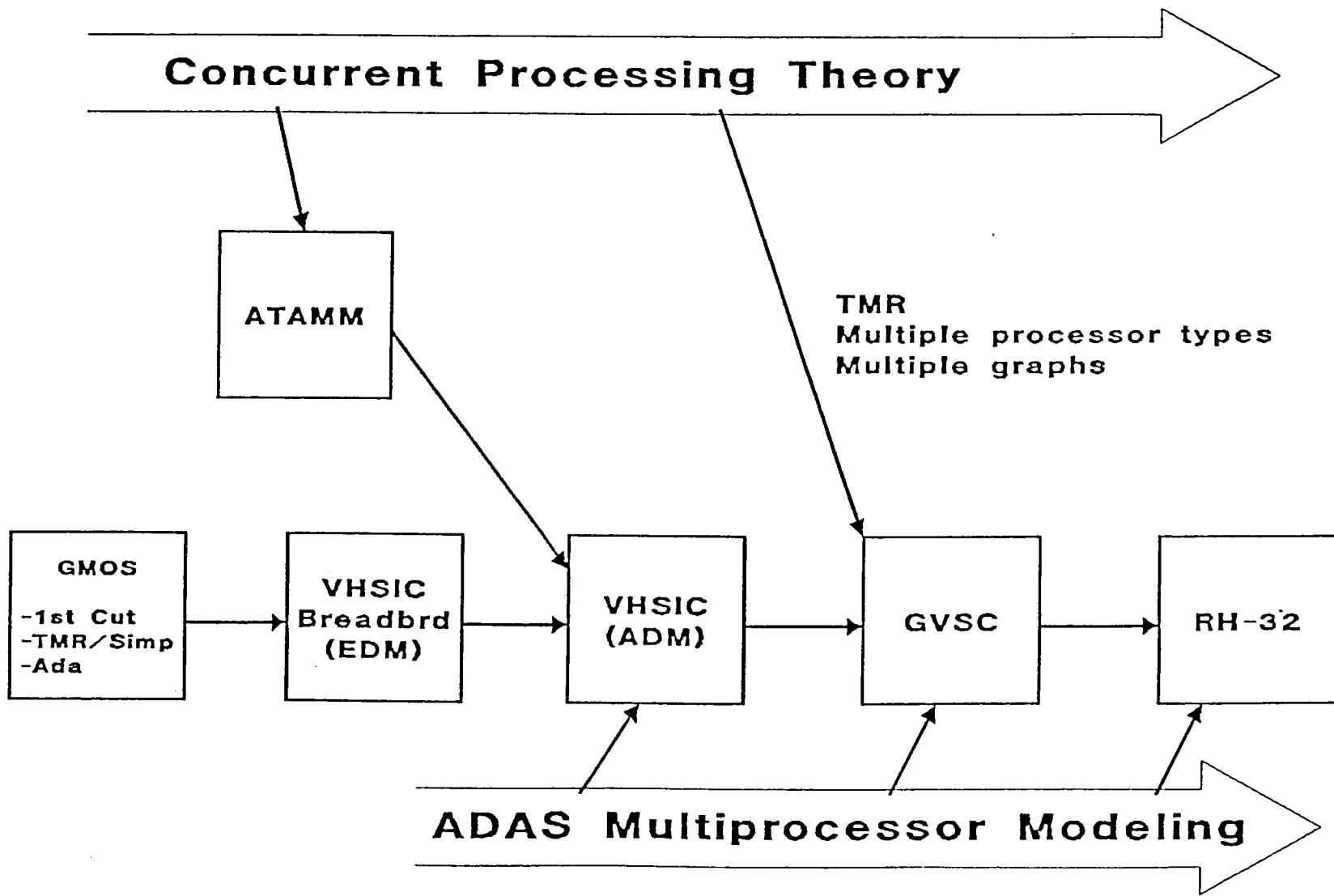
Develop multiprocessor system technology providing user-selectable fault tolerance, increased throughput, and ease of application representation for concurrent operation.

APPROACH

Develop graph management mapping theory for proper performance, model multiprocessor performance, and demonstrate performance in selected hardware systems.

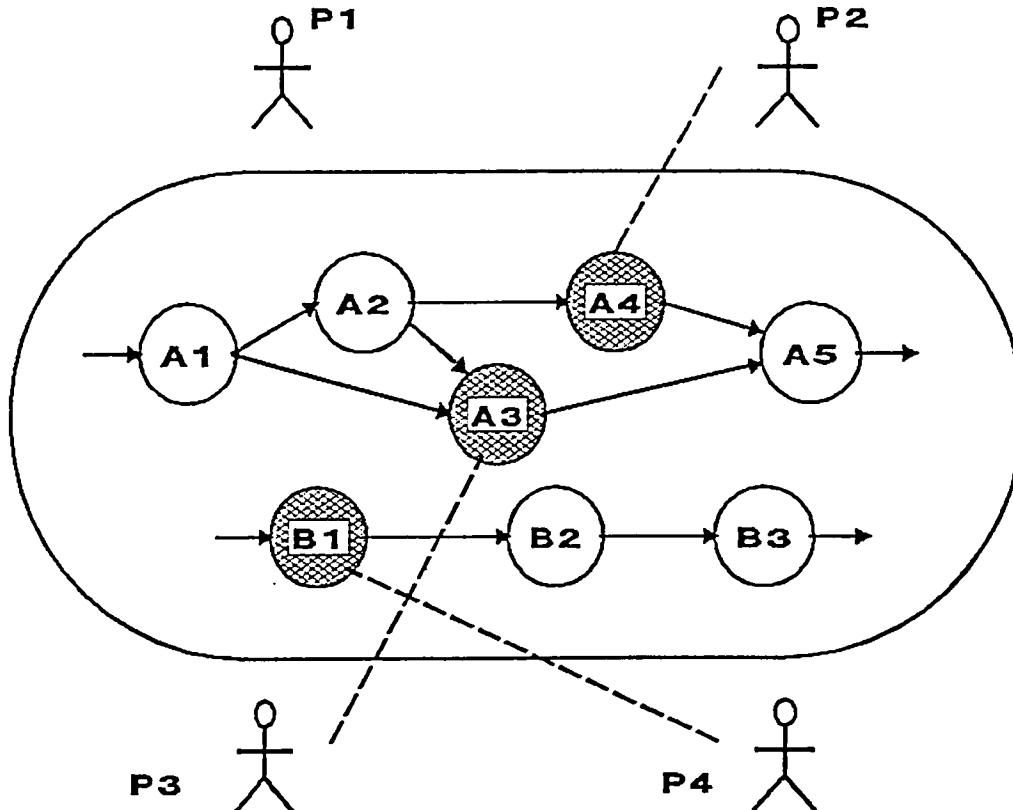
MULTIPROCESSING TECHNOLOGY

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Graph Management Operating System (GMOS)

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**Processor Assignment
for Node Execution**

Features

- o **Distributed O/S and Nodes**
- o **Real-Time Node Assignment**
- o **Application Graph**
- o **Node-Selectable Fault Tolerance**
- o **Ada**
- o **VHSIC 1750A**

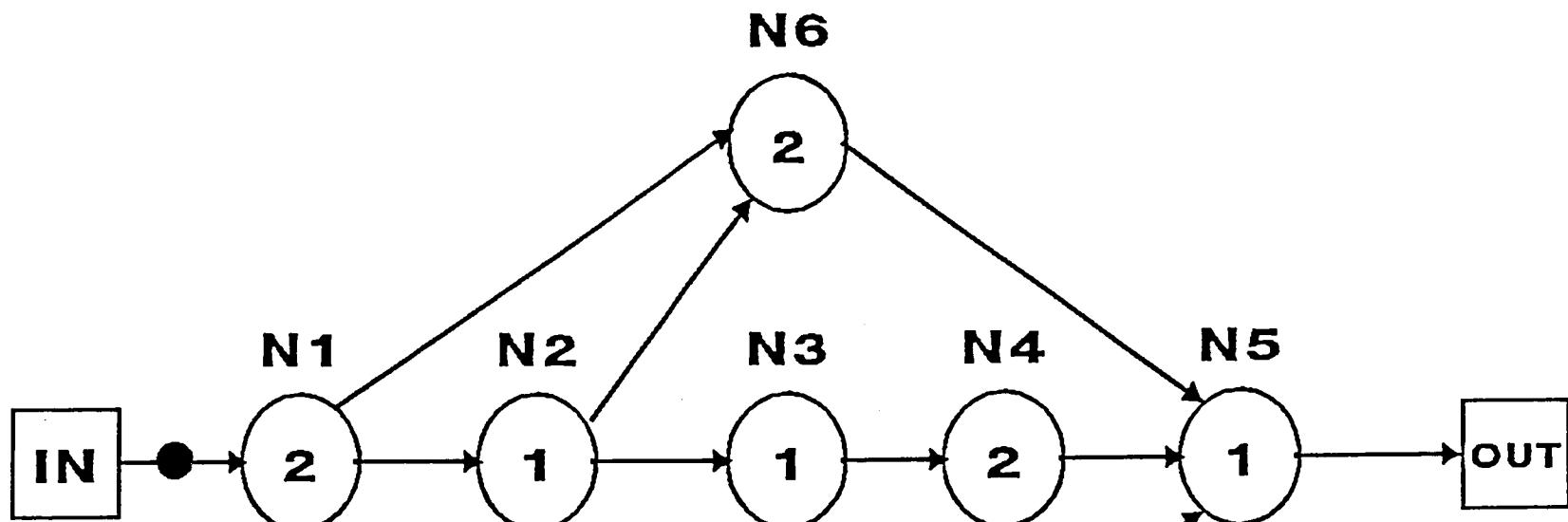
GMOS FUNCTIONAL FEATURES

- EXECUTES DIRECTED GRAPH
 - SINGLE GRAPH
 - MULTIPLE GRAPH
- GRAPH NODE CRITICALITY - TMR OR SIMPLEX
- GRAPH NODE SCHEDULING
 - A) DATA DRIVEN
 - EVENT FLAG
 - SEMAPHORE (MULTIPLE EVENTS)
 - AND/OR LOGIC
 - B) DEMAND DRIVEN
 - PERIODIC TIMER
 - ONE-SHOT TIMER
- BACKUP NODE ALLOCATION
- FAULTY PROCESSOR EXCLUSION, SELF TEST, REBOOT

ALGORITHM TO ARCHITECTURE MAPPING MODEL (ATAMM)

- **A strategy for the real-time assignment of the nodes of a data-driven algorithm graph to parallel processors**
- **Based on Petri-Net marked graph theory**
- **Aimed at large-grain graph applications**
- **Provides:**
 - **deadlock-free performance**
 - **optimum time performance**
 - **operating system rules**
 - **performance prediction**

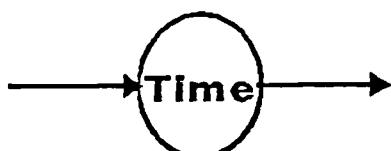
ALGORITHM MARKED GRAPH (AMG) FOR 7-NODE EXAMPLE GRAPH



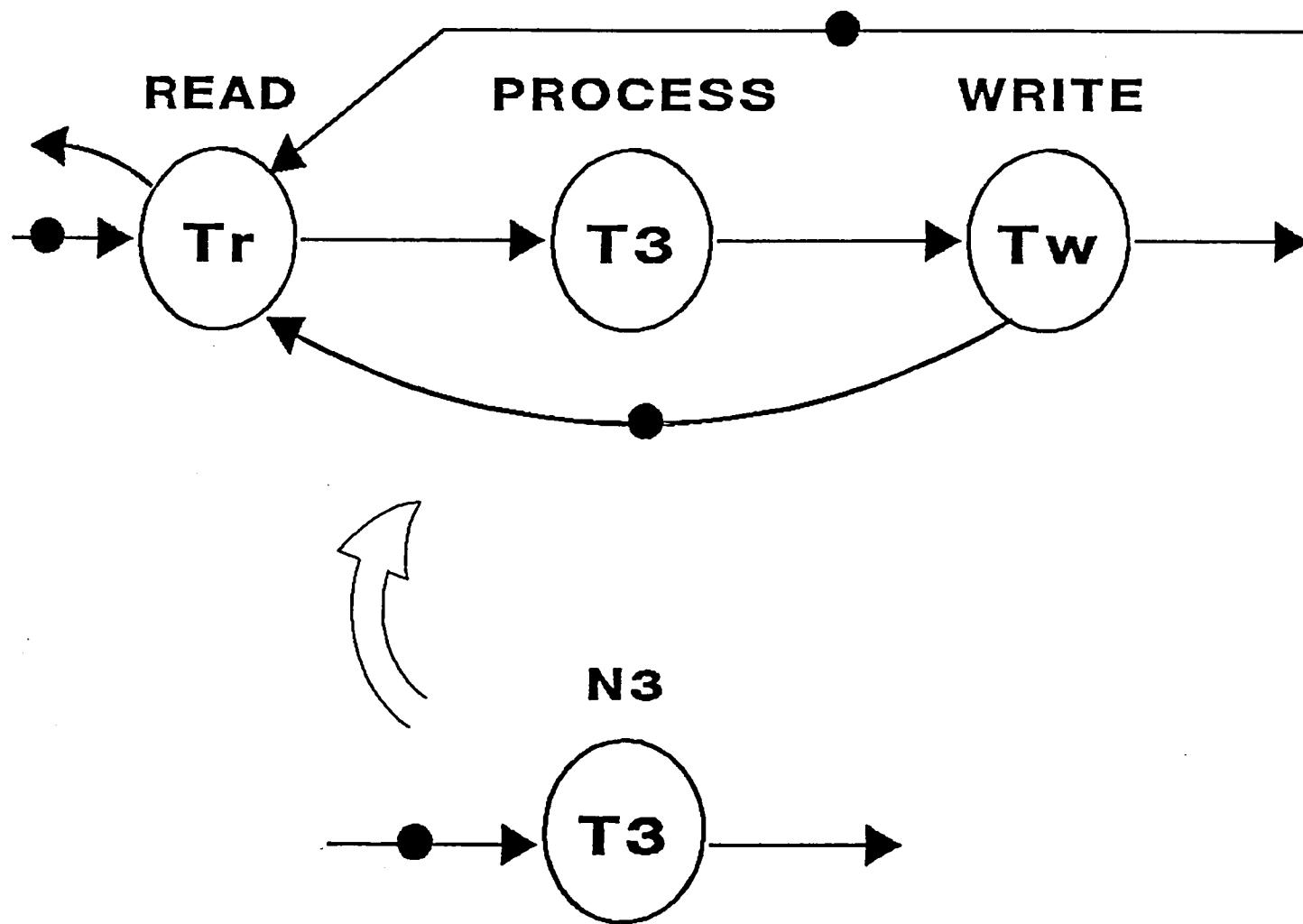
LEGEND:

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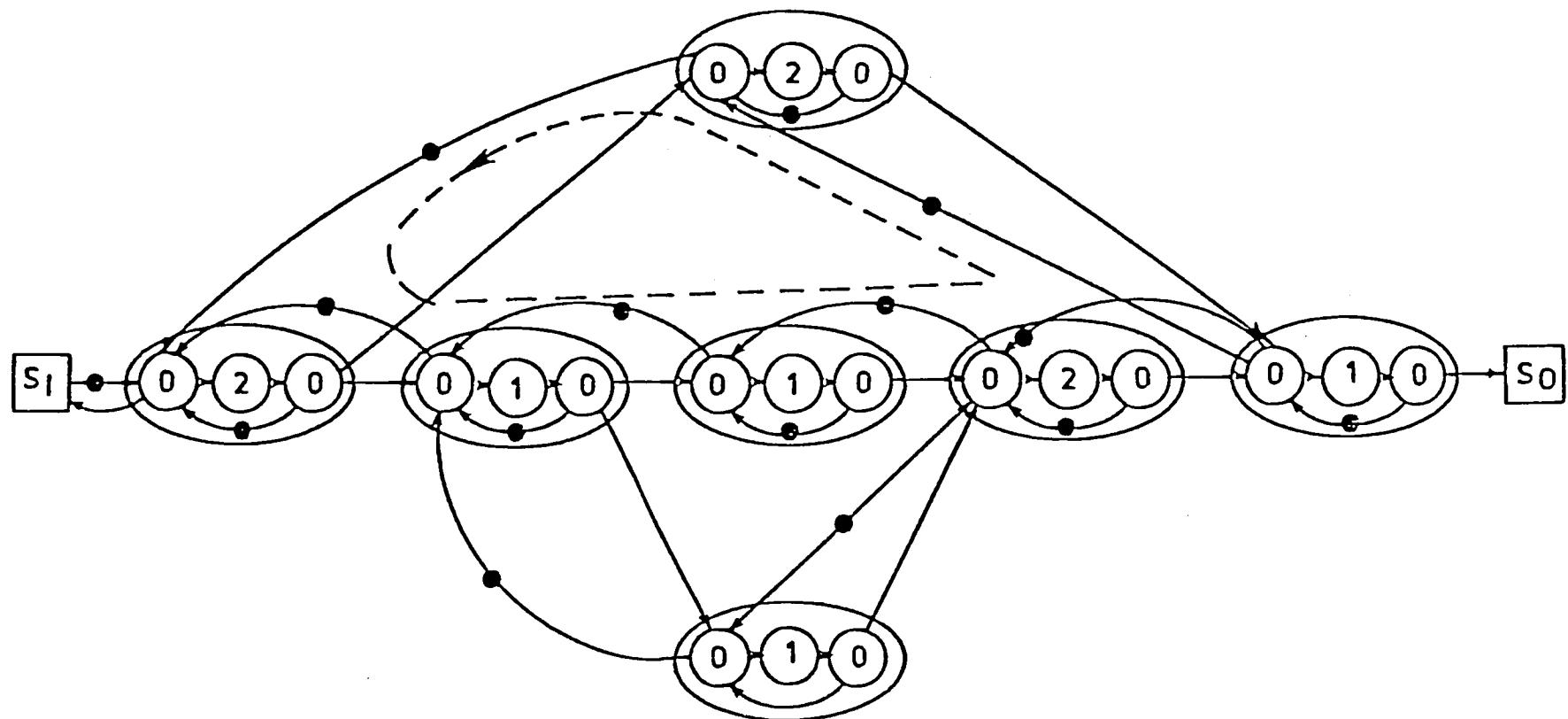
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NODE MARKED GRAPH (NMG) FOR DATA HANDLING



GRAPH FOR ANALYSIS

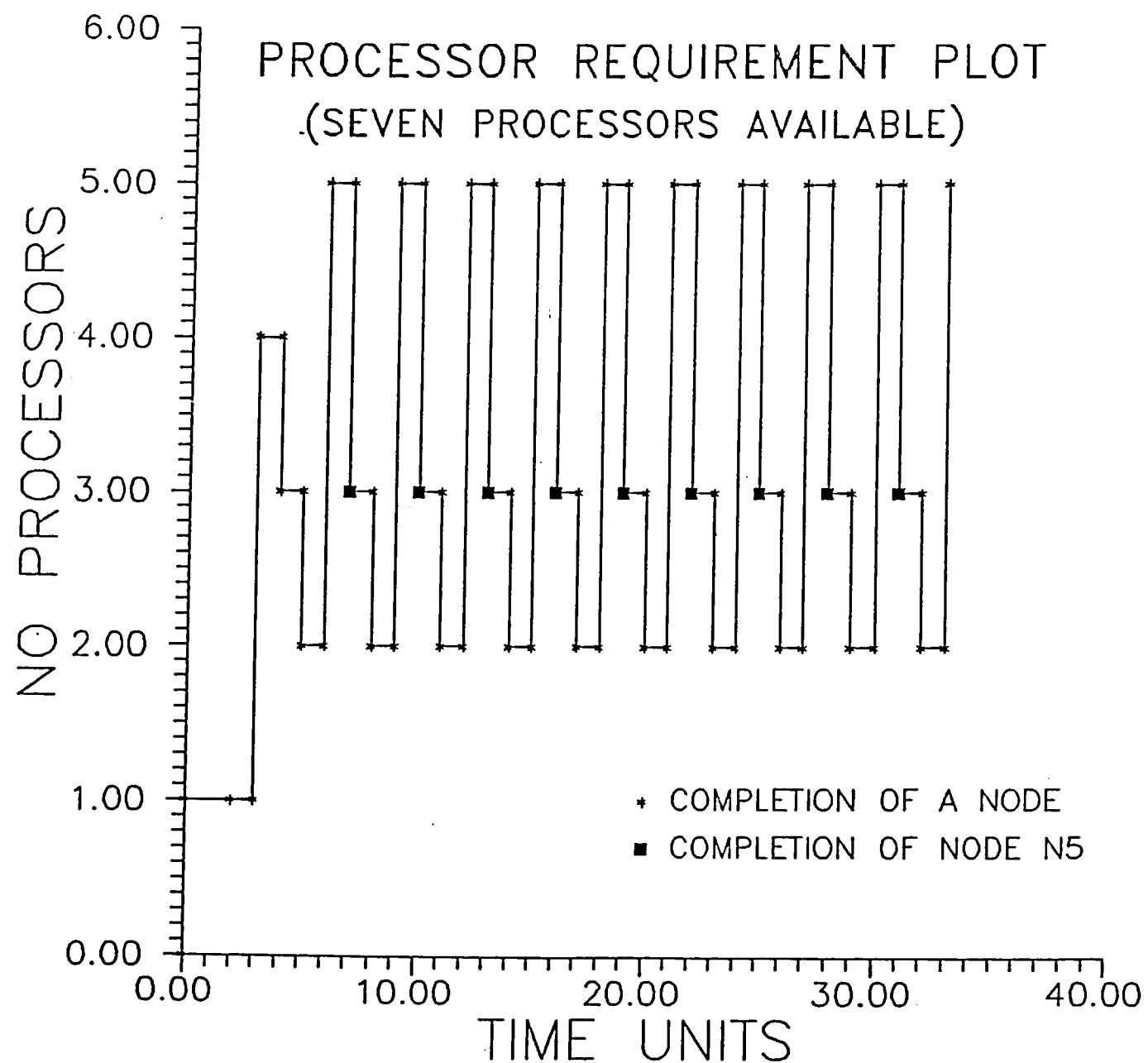


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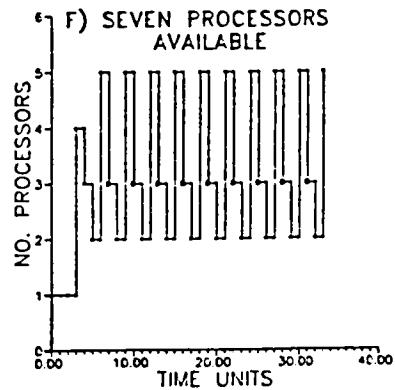
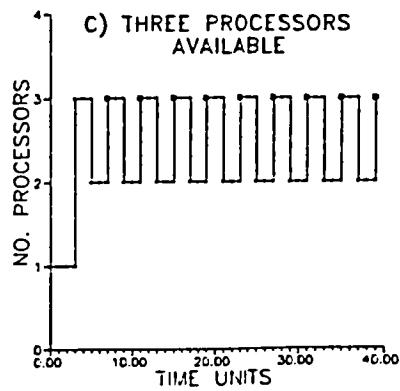
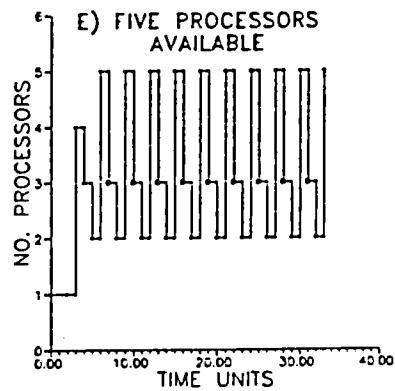
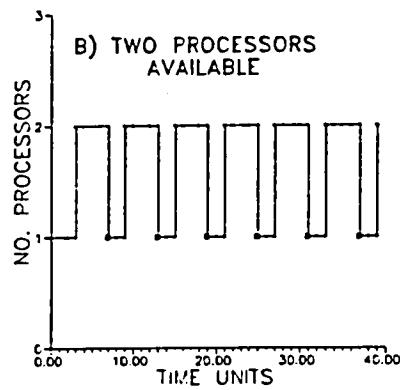
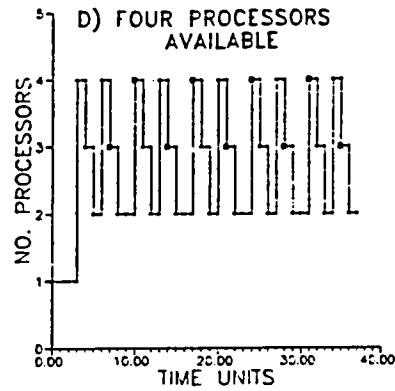
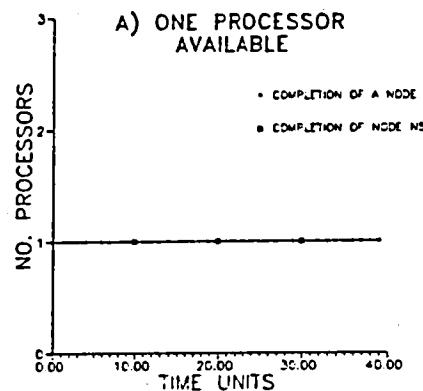
TBO = TIME BETWEEN SUCCESSIVE OUTPUTS

$TBO_M = \text{MINIMUM VALUE FOR TBO}$

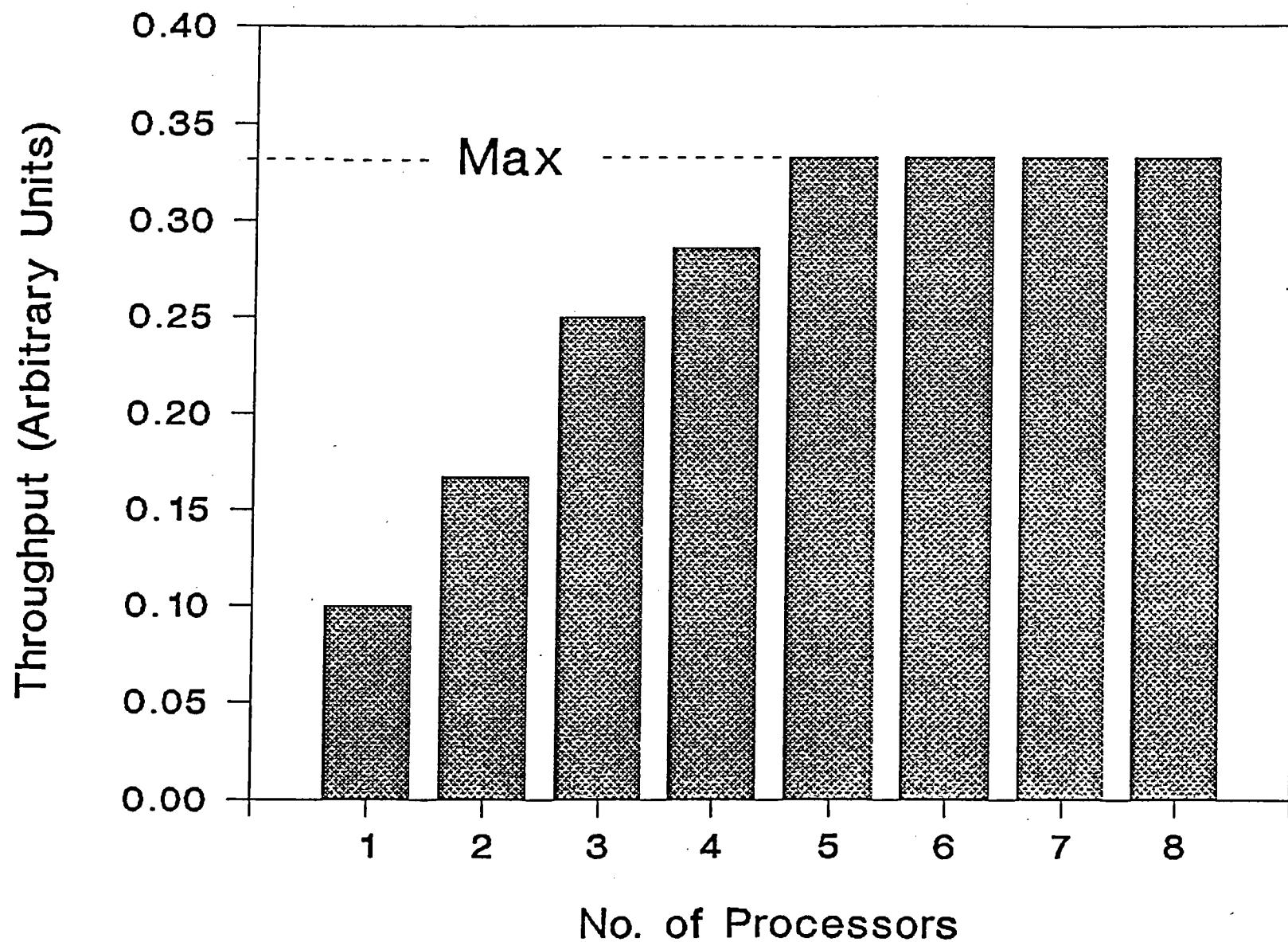
$= \text{MAX}(\text{TIME/NO. TOKENS})_i = 6/2 = 3$



PROCESSOR REQUIREMENT PLOTS

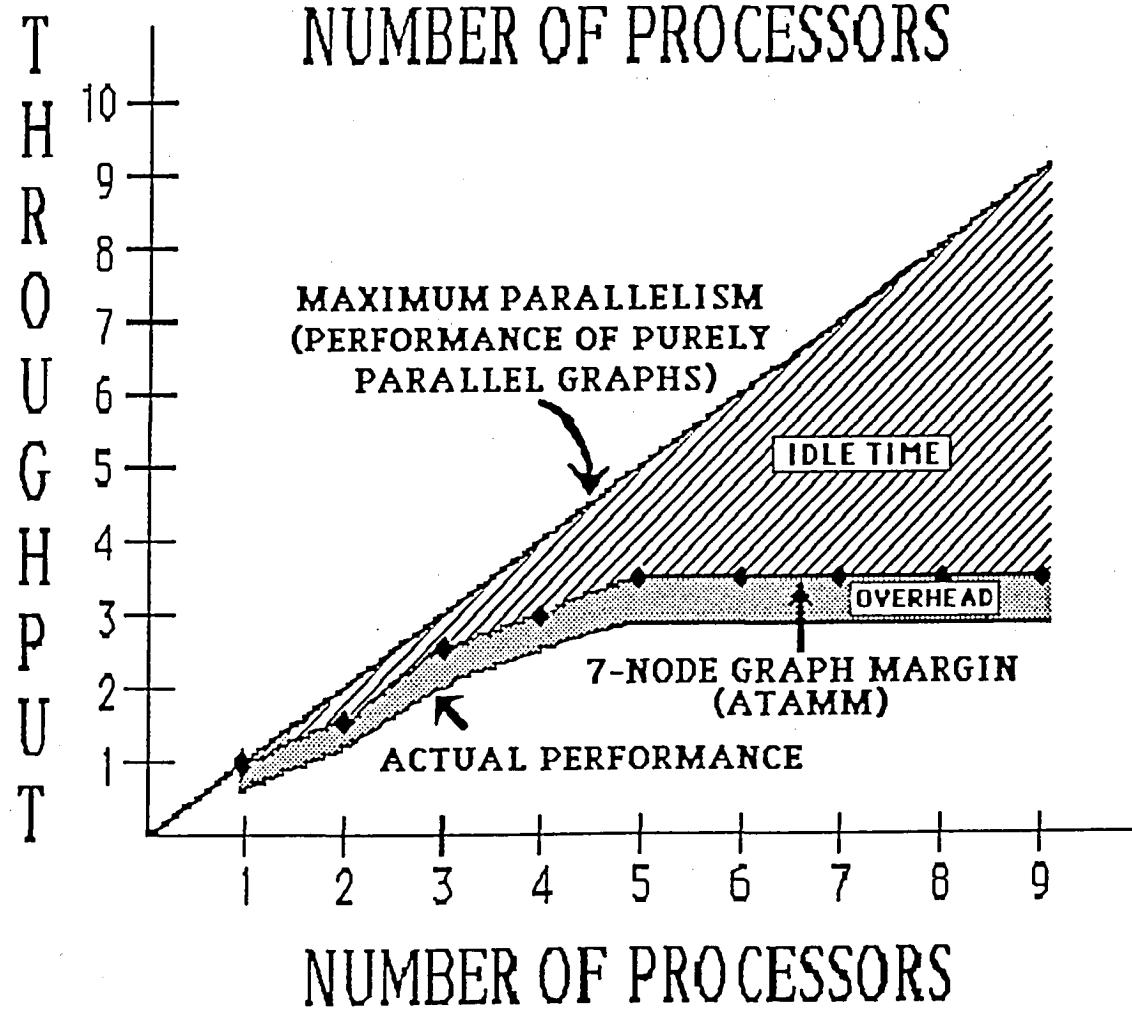


PERFORMANCE MARGIN



NORMALIZED THROUGHPUT VERSUS NUMBER OF PROCESSORS

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ATAMM PROVIDES A NEW CAPABILITY SET

- o **Mathematically proven lock-free performance**
- o **Operating system rules to manage the assignment of graph nodes to processors**
- o **Prediction of graph's performance bounds**
 - **Maximum data rate**
 - **Maximum number of processors**
 - **Dependency of data rate on number of processors**

ATAMM DEVELOPMENT/DEMO PLANS

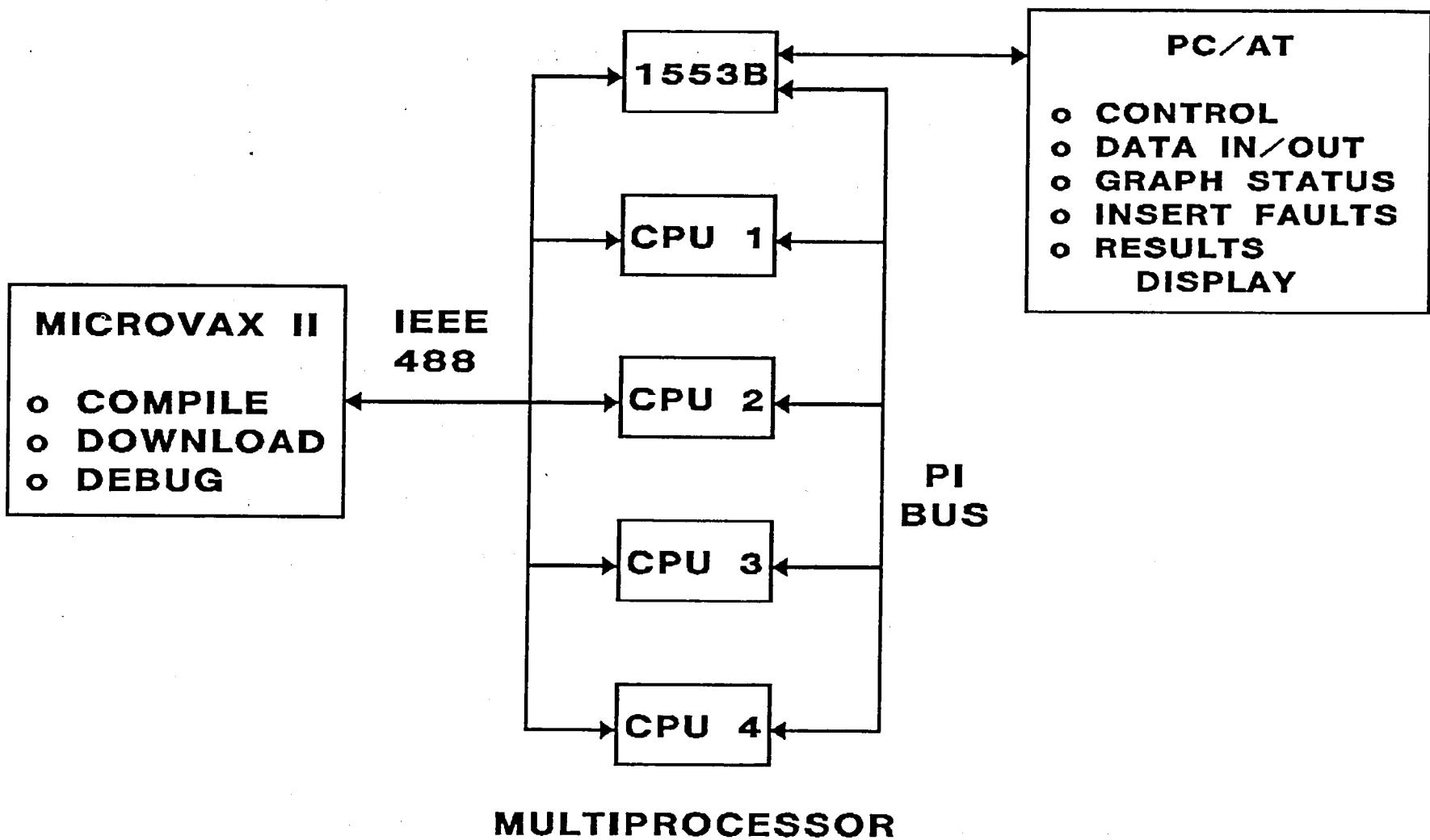
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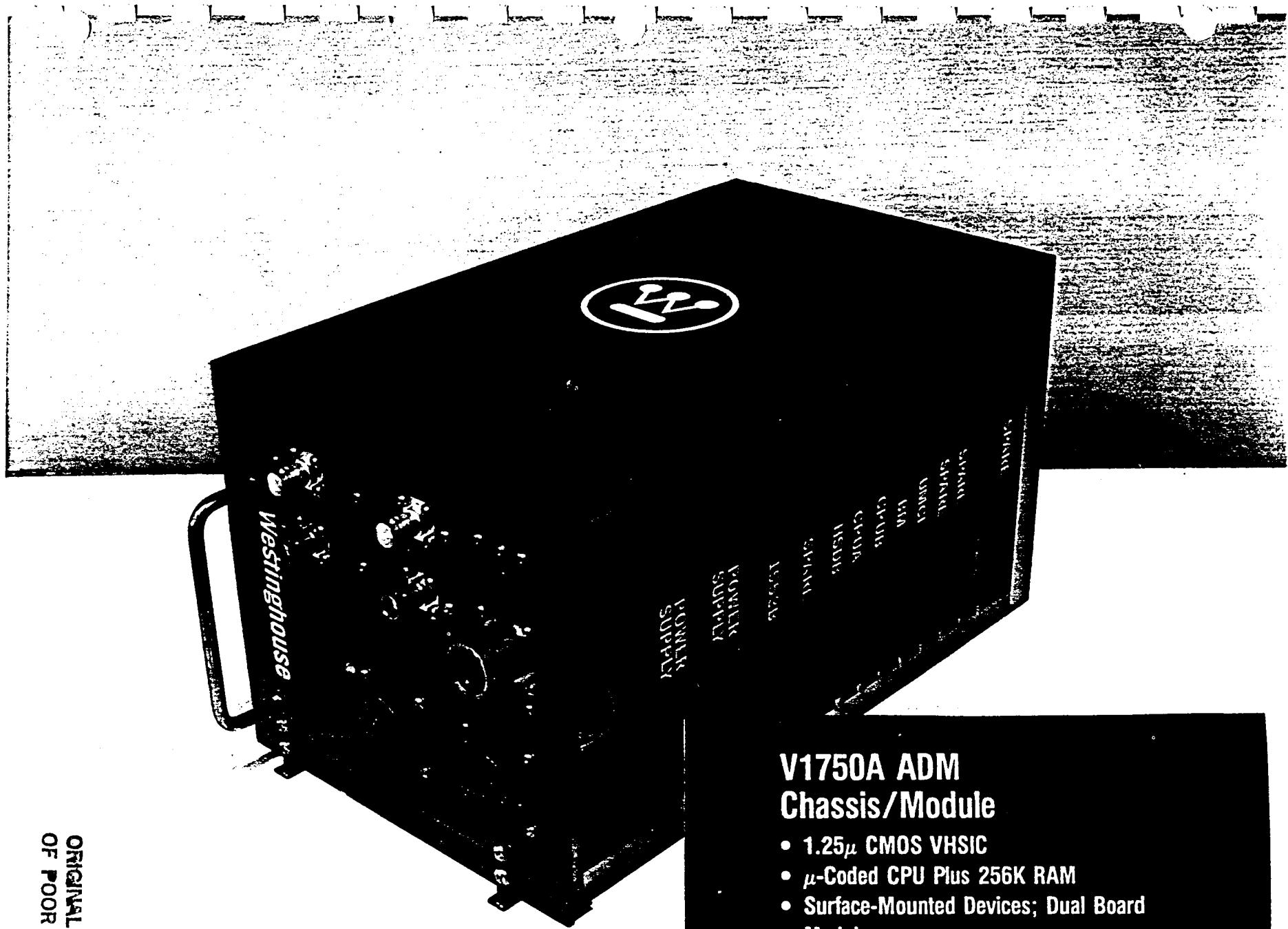
STATUS	FEATURE	DEMO
Initial ATAMM	<ul style="list-style-type: none">o Single graphso Simplexo Identical processors (HW & SW)	ADM
Current Update	<ul style="list-style-type: none">o Triple Modular Redundant (TMR)o Graph optimization for specific no. processors	
Future Features	<ul style="list-style-type: none">o Multiple graphso Multiple iterations of the same grapho Multiple processor typeso Variable node-latency times	GVSC and/or RH-32

MAJOR RESEARCH THRUST FOR FY90

- o **Implement ATAMM Rules into KOS**
 - Simpler operating system than previous GMOS
 - Use Westinghouse Directed Graph Tool
 - Use 1553B to provide data I/O and monitor graph status
 - Improved version of Ada compiler
 - 2.5 MIPS VHSIC ADM 1750A processor
- o **Demo/Evaluate with Ada Algorithms**
 - Test Algorithm (Scan-to-scan track correlation for SDIO)
 - Time-simulated graphs
 - Simplex/TMR
 - Fault injection and continued processing

MULTIPROCESSOR INTERFACE DIAGRAM





V1750A ADM Chassis/Module

- 1.25 μ CMOS VHSIC
- μ -Coded CPU Plus 256K RAM
- Surface-Mounted Devices; Dual Board Module
- 5.88 x 6.44 Inches (SEM-E)

MAJOR PROGRAM MILESTONES

	FY
1) Integrate/Demo ATAMM and SDIO Algorithm on Avionics Advanced Development Model (ADM)	90
2) Adapt/Demo ATAMM-Based OS on GVSC	91
3) Expand ATAMM Capability and Adapt/Demo on RH-32	94